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WORD ASSOCIATIONS AND THE RECOGNITION OF FLASHED WORDS. FINAL REPORT.

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Two separate studies were designed to investigate the effect of reading the first word of a pair on the speed of recognizing the second. One study drew its subjects from the college level; the other from the fourth grade. A Scientific Prototype Three-Channel Tachistoscope was used, and an erasing image was flashed immediately following the presentation of target words to avoid possible after-image effects. Ten word pairs were used. Associative value was measured by the Palermo Jenkins word association norms. Results indicated that word recognition speed was facilitated when associative connections between words in the text matched the word associations of the reader. Recognition was retarded when the target word was preceded by a nonassociate. A target word presented without prior knowledge required more recognition cues than one for which the subject had prior knowledge. Differences between adult and child perception were detected in the reporting of a word based on partial information and in the stronger effect of associative words in children. References are included. (WL)

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CONTENTS

Preface 1

The Problem and Related Literature 2

Method and Materials--Main Study--
College Subjects 3

Results--Main Study 7

Control Study--Adults--Method 7

Results--Control Study 11

Discussion--Adults 11

Main Study--Children--Method 12

Results--Main Study--Children 13

Control Study--Children--Method 13

Results--Control Study--Children 17

Discussion--Children 17

How Recognition of Words Occurs 19

References 23

TABLES

TABLE 1 Paradigm of Experimental Design 5

TABLE 2 Analysis of Variance for 5x5 Repeated-Measures Latin Square Design for Recognition of Words for Adults 8

TABLE 3 Mean Recognition Speed in Milliseconds and Standard Deviations for Target Words for Main Study and Control Study 9

TABLE 4 Newman-Keuls Tests Indicating for Which Treatments Means Recognition Speeds Were Significantly Different from Each Other--- Data for Adults 10

TABLE 5 Analysis of Variance for 5x5 Repeated-Measures Latin Square Design for Recognition Speed of Words for Children 14

TABLE 6 Standard Deviations and Mean Recognition Speeds for Target Words Used in Main and Control Studies--Fourth Graders . . . 15

TABLE 7 Newman-Keuls Tests on Fourth Graders Indicating for Which Treatments Mean Recognition Speeds Were Significantly Different from Each Other 16

PREFACE

This report was made possible through the co-operation and support of many individuals. Thanks are due to Mr. Joel Best and Mrs. Barbara Best who took major responsibility in collecting data. Mr. Keith Nier and Mr. Peter Brownlie also helped in data collection for the control studies. The analyses of the data was done by C. C. Chen. Without the help of the many students of the University of Minnesota and the fourth grade students enrolled in classes in the Minneapolis School system this study would not have been possible. With deep gratitude I also wish to acknowledge the U. S. Department of Health, Education, and Welfare Office of Education for their financial support of this study.

The Graduate School at the University of Minnesota and the Center for Research in Human Learning at the same institution also made significant contributions to this investigation. A special note of appreciation is extended to Professors James J. Jenkins and Wallace A. Russell for their helpful suggestions relating to the design of the study.

THE PROBLEM AND RELATED LITERATURE

When two words are presented in succession, what effect does reading the first word have on speed of recognition of the second word? These studies which are reported here investigated word recognition speed when words were tachistoscopically presented which either did or did not correspond to anticipated word associations.

Word associations have been shown to affect several aspects of reading performance. Samuels (1966) demonstrated that learning to read new words was facilitated when the sequence of words in the printed text matched the child's word associations. While this study examined the effect of word associations, a second study was done to determine the effect of associative strength between words in printed text on reading acquisition (Samuels and Wittrock, in preparation). The data indicated that reading acquisition was facilitated as much by word-pairs having low strength associative connections as by word-pairs having high strength associative connections. Furthermore, reading acquisition was facilitated with all treatments having some degree of associative strength between word-pairs compared to the control treatment which had none. Other aspects of reading strongly influenced by word associations are reading speed and recall (Samuels, 1968). Elementary school and college subjects read a paragraph containing words with high-associative relationships significantly faster and with better recall than a group getting a similar paragraph containing words with low associative relationships. Although this study found that associative relationships between words affects reading speed, precisely how word associations affect speed of word recognition was not demonstrated in this study. By varying orders of approximation to English rather than the associative relationship between words, Morton (1964) demonstrated that time wasting regressive eye movements increased in frequency when the subject read passages which increasingly departed from correct English syntax.

While the foregoing studies were concerned mainly with the effects of word associations on measures such as reading acquisition, reading speed, and recall, a different focus of psychological inquiry has been the effect of word association on the recognition of flashed words. O'Neil (1953) and Rouse and Vernis (1963) demonstrated that when associated words such as "Table-Chair" are tachistoscopically exposed in succession, recognizing the first word aids in recognizing the second word.

In a similar study, Tulving and Gold (1963) reported that as the amount of information in a sentence containing a missing word increased, the time required to recognize the missing word decreased.

As mentioned earlier, word associations affect reading speed, but precisely how they do has not been determined. It seems probable that when the associative connections between words in printed text is high (e.g., white-snow) reading the first word elicits from the reader the associate of that word. If the associate elicited from the reader matches the second word in the text, speed of word recognition should be facilitated. Moreover, when highly associated words appear sequentially in the text, after reading the first word the reader may correctly report the next word in the text without having to visually discriminate that word. Conversely, if the sequence of words in the text does not conform to the word associations of the reader, then reading the first word may elicit an associate which does not match the next word in the text. When this occurs additional fixation time is required before the reader is able to correctly report the word printed in the text. To test these hypotheses regarding the effect of different kinds of word associations on speed of word recognition, subjects in the two experiments to be reported were required to recognize tachistoscopically flashed words under the following five conditions: facilitating, neutral, interfering, and two control conditions. To further determine if in fact subjects would report "seeing" flashed words at speeds significantly below threshold, separate control studies were utilized to determine the threshold for speed of word recognition for the target words used in this study.

As mentioned earlier, two separate studies are reported here. The purpose of the studies, the design, and the procedure are similar. The only difference between the two studies is the population from which the subjects were drawn. The first study to be reported used college subjects while the next study to be reported used forth grade subjects from an elementary school.

METHOD AND MATERIALS--MAIN STUDY--COLLEGE SUBJECTS

Subjects. Twenty juniors enrolled in introductory educational psychology were used. All subjects were given a screening examination with the tachistoscope to insure they could see the flashed words. They were

randomly assigned to rows in a 5x5 repeated-measures Latin square design.

Materials. A Scientific Prototype Three-Channel Tachistoscope was used. To prevent the possibility of after-image effects from the flashed presentation of the target words confounding the results regarding speed of recognition, an erasing image was flashed immediately following the presentation of the target words.

The word-pairs and single words used in the study met the following restrictions: (1) word-pairs formed adjective-noun grammatical units (the noun was the target word which was flashed to measure speed of recognition for all treatments), (2) each of the five treatments had two target words, (3) all tachistoscopically presented words were typed in upper-case to reduce the possibility of using word-shape as a cue for word recognition, (4) the two target words used with each treatment started with the same letter to prevent use of first letter cues in word recognition, (5) word length for target words used in a treatment were as similar as possible, (6) in the neutral treatment, to prevent the possibility that subjects might have idiosyncratic associations between the first word of the pairs used with this treatment and any of the target words used in the study, a pool of four neutral stimulus words were selected for the treatment rather than two, these stimulus words had no known associative connections with any of the target words (each subject was tachistoscopically shown only two neutral stimulus words from the pool of four, the particular two were chosen randomly). The ten word-pairs were: BLUE-SKY (.25), SALTY-SEA (.08), DARK-NIGHT (.18), LOUD-NOISE (.23), BEAUTIFUL-GIRL (.16) GREEN-GRASS (.41), RED-COLOR (.07), SWEET-CANDY (.16), HEAVY-WEIGHT (.06), COLD-WINTER (.08). The decimal number next to each word-pair shows its associative strength for college subjects in the Palermo-Jenkins (1964) word-association norms. The four stimulus words used in the neutral treatment were: LONG, SOUR, THIRSTY, SMOOTH.

Design. To determine the effect of different kinds of word-associations on speed of word-recognition a 5x5 repeated-measures Latin square design was used. Each subject took all five treatments in succession but order of treatment presentation was randomized for each subject. In addition, the word-pairs used with the treatments were counterbalanced for each row of the design. See Table One for a paradigm of the design.

TABLE 1

Paradigm of Experimental Design

Experimental condition	Words used in familiarization training	Words presented with tachistoscope for test of recognition speed
Facilitation (F)	LOUD-NOISE DARK-NIGHT	LOUD-NOISE DARK-NIGHT
Interference (I)	BLUE-SKY SALTY-SEA	BLUE-SEA SALTY-SKY
Neutral (N)	BEAUTIFUL-GIRL GREEN-GRASS	SOUR-GIRL SMOOTH-GRASS
Control$_1$ (C_1)	_____COLOR _____CANDY	RED-COLOR SWEET-CANDY
Control$_2$ (C_2)	_____WINTER _____WEI GHT	_____WINTER _____WEIGHT

Facilitation Treatment. This treatment provided data on speed of recognition for the target word when after reading the first word of a pair the subject anticipated the next word and the same word was flashed.

Interference and Neutral Treatments. These treatments provided data on speed of recognition when after reading the first word of a pair the subject anticipated the following word but a different word was flashed.

Control-1 Treatment. The subject was not familiarized beforehand with the word-associates which were tachistoscopically presented. Data from this treatment allowed comparisons to be made of word recognition speed between treatments in which word-associates were tachistoscopically presented but for which the subject had and had not been familiarized.

Control-2 Treatment. Data from this treatment provided information on recognition thresholds for just the target words. These words had been introduced during familiarization training.

Procedure. Because speed of tachistoscopic recognition is influenced by factors such as length of practice, knowing where to focus, and set, each subject read through a tachistoscopically presented practice list twice. The practice list was exposed at speeds of 100 and 50 milliseconds (ms.). The practice list was analogous to the test list in length, number of single words, and number of associated and non-associated word-pairs.

Following tachistoscopic practice, the subject was given familiarization training with the single words and word-associates as shown in Table One. Since there was no way of knowing a priori if the word-associates as shown in the Palermo-Jenkins (1964) word-association norms were part of a particular subject's associative structure, each subject was familiarized with the word-associates and individual words appropriate for the row of the design to which he was assigned. Familiarization consisted of reading through a pack of thirty cards three times. The pack of thirty cards contained ten different cards repeated in three random orders. Each of the ten cards contained one of the words or word-associates as shown in the paradigm of the design under familiarization training. Thus, six of the cards had adjective-noun pairs and the other four cards had only nouns.

Following familiarization, the subject looked again into the tachistoscope. The test list was then presented. The first word of a pair was shown for 1-sec; the subject read it aloud, and this was followed immediately by the exposure of the target word. The subject then reported the target word, if he could. No feedback was given. Following this, the next word-pair or individual word was shown. The entire test list was shown starting at 20-ms. exposures of the target word and increasing in duration of exposure by 10-ms. The entire list continued to be shown until the subject correctly reported each target word two times. When just the target word was flashed, as in the Control-2 Treatment, first a dot appeared and then the target word was flashed. The subject's speed of recognition was computed by taking the exposure duration of the first and second correct response to the target word and averaging the two.

RESULTS---MAIN STUDY

The analysis of variance for the 5x5 repeated-measures Latin square design indicated that: (1) there was no significant difference among the five groups (rows in the design) of randomly assigned subjects in speed of word recognition ($F = < 1$, 4/15 df), (2) none of the target words (nouns) were read faster than the others ($F = < 1$, 4/60 df), (3) the interaction effect was not significant ($F = < 1$, 12/60 df), but (4) the treatment effect of word-associations on speed of recognition was highly significant ($F = 19.82$, 4/60 df, $p < .001$). See Table Two for the analysis of variance for 5x5 repeated-measures Latin square design for recognition speed of words for adults.

The means and standard deviations for each of the five treatments are shown in Table Three.

To determine for which treatments mean speeds of recognition were significantly different from each other, Newman-Keuls Tests were run. The results are shown in Table Four.

CONTROL STUDY--ADULTS--METHOD

Subjects. Twenty juniors enrolled in educational psychology were used. All were screened to insure they could read the flashed words.

Materials. The tachistoscope with erasing image described earlier was used. Only the ten target words used in the main study were presented.

TABLE 2

Analysis of Variance
for 5x5 Repeated-Measures Latin Square Design
for Recognition Speed of Words for Adults

SV	df	SS	MS	F
Between Ss	19	5505		
A(Groups)	4	800	200.00	<1
Subjects within groups	15	4705	313.67	
Within Ss	80	17698		
B(Treatments)	4	9210	2302.50	19.82xxx
C(Words)	4	426	106.50	<1
AB'	12	1090	90.83	<1
Error within	60	6972	116.20	

xxx p < .001

TABLE 3

Mean Recognition Speed in Milliseconds and Standard Deviations for Target Words for Main Study and Control Study

Treatment	Mean Recognition Speed	Standard Deviation
Facilitation	35.00	5.57
Control-1	40.00	11.00
Control-2	47.55	13.04
Interference	56.65	14.76
Neutral	60.35	13.27
Control Study	61.37	7.42

TABLE 4

Newman-Keuls Tests Indicating for Which Treatments Means Recognition Speeds Were Significantly Different from Each Other--Data for Adults

	F	C-1	C-2	I	N
F		NS	**	**	**
C-1			NS	**	**
C-2				*	**
I					NS

** P < .01
* P < .05

Procedure. The subject was first given practice recognizing flashed words using a practice list consisting of nouns which were similar to those used in the test list. The practice list was presented at speeds of 100-ms. and 50-ms. After practice, the ten target words from the test list were presented starting at exposure durations of 20-ms. Exposure duration was increased by 10-ms. each time the list was repeated. With each repetition of the list the target words were shown in a different sequence. No feedback was given, and the entire list was repeated until the subject reported each word correctly twice.

RESULTS--CONTROL STUDY

As seen in Table Three, the mean recognition speed for the Control Study was 61.37-ms., which represents the longest exposure required for recognition. Recognition speed for the Control-2 Treatment, in which familiarized target words were shown, was significantly faster than was recognition speed for the Control Study ($t = 4.02$, $df = 38$, $p < .01$).

DISCUSSION--ADULTS

The purpose of this study was to determine the effect of associative connections between words on speed of word recognition. It was hypothesized that when the word-associations of the reader matched the associative connections between visually presented word-pairs, speed of recognition would be facilitated. Conversely, when the word-associations of the reader did not match the associative connections between visually presented word pairs, speed of recognition would be retarded. The third question under investigation was: could subjects recognize words at sub-threshold speeds, and if so, under what conditions?

As predicted, word-recognition speed was facilitated when associative connections between words in the text matched the word-associations of the reader. Furthermore, no significant difference in recognition speed was found between the Facilitation and the Control-1 Treatment. In the Facilitation Treatment the subject was familiarized with the word-associates before they were visually presented, whereas in the Control-1 Treatment the subject was not familiarized with the word-associates beforehand. Thus, when comparing the two treatments in which associated word-pairs were visually presented with the three treatments in which associated word-pairs were not presented, it was found that speed of recognition was significantly faster for the two treatments in which target words were preceded by their associates.

Another hypothesis supported by the data was that recognition speed would be significantly retarded if the target word was preceded by a non-associate. Speed of recognition for the Neutral and Interference Treatments, in which non-associated word-pairs were presented, was significantly slower than it was for the Control-2 Treatments, in which just target words were shown. Neither the Neutral nor the Interference Treatments were significantly different from each other in recognition speed.

Finally, it was found that recognition speed in the Facilitation and Control-1 Treatments was at sub-threshold, using the Control-2 Treatment as a baseline, whereas Control-2 was a sub-threshold using the Control Study as a baseline. In the latter study, subjects had no prior knowledge of what words were to be presented. Since the same subjects were used for all treatments in the Main Study, and since they recognized words at sub-threshold speeds in some treatments but not in others, sub-threshold recognition can be assumed to be influenced by word-associations and knowledge of the domain from which target words were drawn.

MAIN STUDY--CHILDREN--METHOD

Subjects. Twenty fourth graders enrolled in a Minneapolis elementary school were used. All subjects were given a screening examination with a tachistoscope to insure they could see the flashed words. They were randomly assigned to rows of a 5x5 repeated-measures Latin square design.

Materials. A Scientific Prototype Two-Channel Tachistoscope was used. To prevent the possibility of after-image effects from the flashed presentation of the target words confounding the results regarding speed of recognition, an erasing image was flashed immediately following the presentation of the target words. Exactly the same word-pairs used in the study using college subjects were used again with the fourth graders. The ten word-pairs were: BLUE-SKY (.08), SALTY-SEA (.02), DARK-NIGHT (.21), LOUD-NOISE (.16), BEAUTIFUL-GIRL (12), GREEN-GRASS (.17), RED-COLOR (.30), SWEET-CANDY (.10) HEAVY-WEIGHT (.05), COLD-WINTER (.06). The decimal number next to each word pair shows its associative strength for fourth grade subjects in the Palermo-Jenkins (1964) word-association norms.

Design. The same design used for college subjects was used with the elementary school subjects. In fact,

this study using elementary school children was a replication of the earlier study in order to determine the degree of generalizability of the findings. The reader is referred back to Table One for a paradigm of the design.

Procedure. The same procedure used with college subjects was used again with the children with one exception. Since one could not be sure that these fourth graders were able to read all of the words used in the study, and since it was absolutely essential that they be able to do so, all fourth grade subjects in the school were tested two weeks before the study began to determine if they were able to read the words. This pretesting was done by typing the word used in the study on index cards along with some dummy words which were not included in the design. On each index card one word appeared. The subjects were asked to read the words to the experimenter. If any subject was unable to read the words which were included in the design the subject was immediately eliminated from the experiment. The twenty remaining subjects were randomly assigned to one of five rows in the design.

RESULTS--MAIN STUDY--CHILDREN

The analysis of variance for the 5x5 repeated-measures Latin square design indicated that: (1) there was no significant difference among the five groups (rows in the design) of randomly assigned subjects in speed of word recognition ($F = 2.02$, 4/15 df), (2) none of the target words (nouns) were read faster than the others ($F = 1.81$, 4/60 df), (3) the interaction effect was not significant ($F = 1.08$, 12/60 df), (4) the treatment effect of word associations on speed of recognition was highly significant ($F = 67.18$, 4/60 df, $p < .001$).

See Table Five for the analysis of variance on recognition speeds for children.

The means and standard deviations for each of the five treatments are shown in Table Six.

To determine for which treatments mean speeds of recognition were significantly different from each other, Newman-Keuls Tests were run. The results are shown in Table Seven.

CONTROL STUDY--CHILDREN--METHOD

Subjects. Thirty fourth graders enrolled in a Minneapolis elementary school were used. All subjects were pretested two weeks before the experiment was run

TABLE 5

Analysis of Variance
for 5x5 Repeated-Measures Latin Square Design
for Recognition Speed of Words for Children

SV	df	SS	MS	F
Between Ss	19	5087		
C(Groups)	4	1782	445.5	2.02
Subjects within groups	15	3305	220.3	
Within Ss	80	45707		
A(Words)	4	947	236.8	1.81
B(Treatments)	4	35203	8800.8	67.18^{xxx}
AB'	12	1698	141.5	1.08
Error within	60	7859	131.0	

xxx $p < .001$

TABLE 6

Standard Deviations and Mean Recognition Speeds for Target Words Used in Main and Control Studies--Fourth Graders

Treatment	Mean Recognition Speed--Milliseconds	Standard Deviation
Control-2	30.50	6.26
Facilitation	32.25	9.93
Control-1	51.95	13.75
Neutral	69.40	13.29
Interference	76.60	17.87
Contrc Study	46.50	9.54

TABLE 7

Newman-Keuls Tests on Fourth Graders
Indicating for which Treatments
Mean Recognition Speeds Were Significantly
Different from Each Other

	C-2	F	C-1	N	I
C-2		NS	**	**	**
F			**	**	**
C-1				**	**
N					NS

** P < .01

to insure they could read the words which were to be flashed. The pretesting included filler words not used in the experiment proper.

Materials. A Two-Channel Tachistoscope was used. The ten target words used in the main study were presented.

Prodecure. Exactly the same procedure used in the control study for college subjects was used with the children. The only difference being that the children were pretested to insure they would be able to read the presented words.

RESULTS--CONTROL STUDY--CHILDREN

As seen in Table Six, the mean recognition speed for the Control Study was 46.50-ms. Recognition speed for the Facilitation Treatment was 32.25-ms., for the Control-1 Treatment it was 51.95-ms., and for the Neutral Treatment it was 69.40-ms. The data from the latter three treatments is correlated since the same subjects were used in these treatments. If one were to make multiple t-test comparisons between these three treatments and the seperate Control Study, in which an independent sample was used, assumptions regarding independence of sampling would be violated. With full knowledge that one of the assumptions regarding the t-test was violated, three t-tests were computed, the purpose being to determine for which treatments in the Main Study were speeds of recognition significantly faster or slower than threshold. Threshold of word recognition was determined by recognition speed in the Control Study. The t-tests indicated that recognition speed was significantly faster than threshold for the Facilitation Treatment ($t = 5.00$, $df = 48$, $p < .001$). Recognition speed was significantly slower than threshold for the Neutral Treatment ($t = -6.94$, $df = 48$, $p < .001$). Recognition speed for the Control-1 Treatment was not significantly different from threshold ($t = -1.63$, $df = 48$, $.10 < p < .20$).

DISCUSSION--CHILDREN

The objective of this study, which used fourth graders as subjects was to determine the effect of associative connections between words on speed of word recognition. In the Main Study, the children recognized target words under five treatment conditions. All the tachistoscopically presented target words had been visually presented earlier during familiarization training. What was unknown to the child was the context in which the target words would appear.

The hypotheses underlying this study were that: (1) recognition speed would be faster when anticipated words were presented, (2) recognition speed would be slower when the word pairs presented did not conform to what the subject anticipated, (3) recognition speed would be faster for the Control-2 Treatment, in which the subjects had been familiarized with the single target word presented, than it would be for the Control Study, in which the subject had no knowledge of the domain from which the single target words would be selected.

The data on word recognition speed support the hypotheses. All treatments in which the target word was presented in the context of a word association were recognized significanlty faster than when target words were not presented in the context of associatively connected word pairs. For example, as seen in Table Seven, recognition speed for the Facilitation and Control-1 Treatment, in which associated word pairs were presented, was significantly faster than for the Neutral and Interference Treatments, in which non-associated word pairs were presented. Also, recognition speed for the Control-2 Treatment, in which familiarized target words were presented, was significantly faster than for the same target words which were presented in the Control Study. In this latter study subjects had not been familiarized with the target words beforehand, and thus they did not know the domain from which the target words would be selected.

An interesting way to look at this data from children for both the Main Study and the Control Study is to rank-order the treatments in terms of speed of recognition. When we do this we find: Control-2, Facilitation < Control Study, Control-1 < Neutral, Interference. A line connecting two treatments indicates no significant difference between the treatments in recognition speed. A separation of the line indicates there are significant differences in recognition speed among the treatments not joined by the same line. Thus one can see that there is no significant difference in recognition speed between Control-2 and Facilitation, the Control Study and Control-1, and Neutral and Interference; but Control-2 and Facilitation are significantly different from Control Study and Control-1, and Control Study and Control-1 are significantly different from Neutral and Interference.

The placement of two of the treatments within the rank-ordering of treatments deserves special attention. These two treatments are Control-2 and Control-1. One might ask, why should speed of recognition be so fast for the Control-2 Treatment, faster even than it was for Control-1? Secondly why is it that recognition for the

Control-1 Treatment is significantly slower than it was for the Facilitation Treatment, when for adults there was no significant difference between these two treatments?

In the Control-2 Treatment, the subject had been familiarized with the two target words used in the treatment. These same words were presented with a tachistoscope without any word preceding them. If the subject perceived just the first letter of the target word when it was flashed, then matched the letter perceived with the word presented during familiarization, and was willing to guess at the word, he had a 50-50 chance of being right. If the subject perceived more than just the single letter and was willing to base his report on partial information, the probability of being correct was higher than .50. It appears that speed of recognition for children was fastest for the two treatments in which the same words were flashed that were studied previously during familiarization training. These two treatments were the Facilitation and Control-2 Treatments.

In comparing children and adults in the rank-ordering of treatments, children recognized target words significantly faster in the Control Study than in the Neutral and Interference Treatments. With adults there was no difference in recognition speed among these three treatments. This suggests that for children word recognition is more difficult when word pairs are presented in which the first word of the pair elicits an associate which does not match the visually presented flashed target word. For example, the first word presented is "dark". The child anticipates that the next word will be "night". Instead, the word which is flashed is "noise". Under this condition the child does less well than the adult.

Several tentative conclusions with regard to the recognition of words by children seem apparent from the data. First, recognition seems to be facilitated when the same stimuli are flashed which the child had studied during familiarization training, e.g., Control-2 and Facilitation Treatments. Second, recognition seems to be hindered when word-pairs are flashed which are not the same as those studied during familiarization.

HOW RECOGNITION OF WORDS OCCURS

The results of these studies suggest how speed of word recognition is facilitated or retarded. If a target word is presented without prior knowledge of what the word might be, more cues are required for recognition

than if the subject has prior knowledge or can anticipate the word. While the reports of Cattell (1885) stated that short familiar words were responded to as a whole, the same studies demonstrated that as words became less familiar, recognition required letter-by-letter discrimination. In these studies, when associated word-pairs were presented, as in the Facilitation Treatment, reading the first word provided information about the following word. If the subject perceived a single letter or group of letters when the target word was flashed, and if these cues matched the word he anticipated, there was a high probability that his anticipation was correct. Thus, in the Facilitation Treatment, the subject was able to recognize the target word at sub-threshold speeds when he perceived only partial cues.

An interesting question arises as to why recognition speed for non-familiarized word associates (Control-1 Treatment) in the adult study was about as fast as it was for familiarized word associates (Facilitation Treatment). Rouse and Vernis (1962) suggested that low strength word-associates are recognized as fast as high strength word-associates because of three processes: these processes being set (i.e., the strategy of guessing associates), the activation of a hierarchy of associations to the first word of the pair, and verification of guesses by partial perceptions.

The same three processes which explain sub-threshold recognition when associated word-pairs were presented can explain slower speed of recognition when non-associated pairs were presented. In the Interference Treatment, when word pairs were tachistoscopically presented, recognizing the first word activated a hierarchy of word-associates. For example, if SALTY-SKY had been flashed, after reading "SALTY" the subject would probably have anticipated, "SEA". A partial perception of the target word might have been only to letter"S". Since the perception of a single letter matched part of the word which the subject anticipated, he probably would have reported the wrong word, if he were willing to base his report on a partial perception. The subject then would have continued to give the wrong word until he perceived enough letters to realize he was incorrect. Thus, the set to respond associatively and partial perception may interfere with accurate recognition. The willingness to report a word based on partial information is negatively correlated with age, i.e., the younger the subject the more willing he is to give his report even though there is ambiguity in the stimulus situation. Kagan (1965) reports that the subjects willingness to give a verbal report based on what might be an ambiguous perception is part of an individuals reflective-impulsive style.

In the Neutral Treatment, if a partial perception from the target word matched one of the word associates activated by reading the first word of the pair, then the interaction of set and partial perception might have led the subject to report the wrong word. If a partial perception did not match one of the word-associates which were activated, then recognition had to await the perception of enough cues to provide a basis for accurate responding.

With but few exceptions, the same general processes as described for adults apply to recognition of words by children. These exceptions refer to the rapid recognition of target wrods presented alone and the longer time required to recognize a word-associate which had not been familiarized. If the age level trend in impulsivity and reflectivity described by Kagan (1965) can be extrapolated to include the adult, then the implications are that the child is more impulsive than the adult and when faced with an ambiguous stimulus situation with high response uncertainty the response latency for the child will be shorter than for the adult. In other words, the adult reflects, hesitates, attempts to gather more information, and is less willing to make a mistake or to guess, and thus, gives his response only after he is reasonable certain that he is correct. Under certain conditions of stimulus uncertainty, such as in the Control-2 Treatment, the child is more likely than the adult to report the word as soon as he thinks he knows what it is.

Another area of difference between children and adults relates to how word recognition occurs with associatively connected words which either have or have not been introduced during familiarization. As mentioned earlier, the difference in recognition speed between low and high strength word-associates is not significant for adults because of three processes: the strategy of guessing associates, the activation of a hierarchy of associations to the first word of the pair, and verification of guesses by partial perceptions. Contrary to what was found with adults, when the children in this study were presented associatively connected words, familiarized word-associates were recognized faster than non-familiarized associates. The three processes adults used in recognizing associatively connected words appear to operate simultaneously. The strategy the children used to recognize associatively connected words appears to be less sophistocated than that used by the adults, that is the three processes do not seem to function together. Children do develop a set to guess associates. They do verify guesses by means of partial perceptions, and they can give a

hierarchy of responses to a stimulus word. The critical question is, can children simultaneously match a hierarchy of words from a word association response hierarchy with the partial perception from the target word? The actual process the children use may be as follows: (1) there is a set to guess associates, after recognizing the stimulus word, (2) there is the elicitation of a single associate to the stimulus word, (3) there is the verification or rejection of the associate selected based on partial perception, and (4) if the associate is rejected, the next response in the hierarchy is selected.

The same processes which influence speed of word recognition in this study can explain how reading speed is influenced in reading meaningful connected prose. Various cues, for example, from context as well as from syntagmatic word associations, help the reader anticipate what the following words will be. If the reader's partial perceptions match the words he anticipates, he can read rapidly, never having to discriminate all the letters. The utilization of partial cues can continue until the anticipations and partial perceptions no longer support each other or until the reader realizes that what he is reading is not longer meaningful. To the extent that the syntax and word associations in a passage are familiar will the reader be able to read rapidly. When syntax and word sequence of the text are unfamiliar, reading time will be slower because more letters in the word will have to be discriminated in order to recognize the word. Eye movement photography has shown that reading time can be separated into fixations, interfixations, and regressions. Fixations can be further separated into stabilization time, seeing time, and central-processing time. It would appear that when words in the text match the words which the reader anticipates, seeing time, time-wasting regressions, and also, possibly, central-processing time are reduced.

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